(*b*) *Steel Work.*

Provided the quality of the steel complies with the conditions prescribed for furnace plates [see rule 35 (*b*)], when steel furnaces are machine-made by Messrs. The Leeds Forge Company, of the Fox corrugated and Morison suspension types, or by Messrs. John Brown and Company, Sheffield, of the Purves ribbed and grooved type, if they are practically true circles, and the plates not less than $\frac{5}{16}$ inch thick, the working pressure is found by the following formula:

$\frac{C \times T}{D}$ = Working pressure, in lbs. per square inch.

C = 14,000.

T = Thickness, in inches.

D = Outside diameter, in inches, measured at the bottom of the corrugations when the furnace is of the corrugated or suspension type, or over the plain parts when it is of the ribbed and grooved description.

In Fox's corrugated furnaces the pitch of the corrugations and the length of the plain parts at the ends should not exceed 6 inches, and in Morison's suspension furnaces the pitch should not exceed 8 inches, and the length at the ends 5 inches. In both descriptions of furnaces the depth from top of corrugations outside to bottom of corrugations inside should not be less than 2 inches, and the plates at the ends should not be unduly thinned in the flanging.

The plates of ribbed and grooved furnaces should be formed by rolling, the ribs should not be less than 1 $\frac{5}{16}$ inches above the plain parts, and the depth of the grooves not more than $\frac{3}{4}$ inch, the length between the centres of the ribs not over 9 inches and that of the plain parts at the ends not over 6 inches, and the ends rolled slightly thicker than the plain parts, and not reduced at any part by flanging, &c., below the thickness of the body of the furnace.

If the furnace is riveted in two or more lengths the case should be submitted to the Senior Inspector for consideration.

APPENDIX E.

(*See rule 113.*)

Cylindrical Boiler Shells.

Joints with drilled holes.

(*for punched holes, see N.B. at the end*).

Formulæ for ordinary chain riveted and ordinary zigzag riveted joints, and for joints of these descriptions when every alternate rivet in the outer, or in the outer and inner, rows have been omitted (see figures attached).

Let E = Distance from edge of plate or strap, to centre of nearest row of rivets, in inches.

V = Distance between rows of rivets, in inches.

V^1 = Distance between inner and middle row of rivets, in inches, for joints J and K (Figs. 19 and 15).

B = Safe working pressure of steam in boiler, in lbs. per square inch.

C = 1 for lap or single butt joints.

C = 1·75 for double butt joints.

d = Diameter of rivets, in inches.

D = Maximum inside diameter of boiler, in inches.

F = Factor of safety for shell plates.

F^1 = Do. do. rivet sections.

n = Number of rivets in one pitch.

e.g., one in figures 1 and 8.

two do. 2, 3, 9 and 10.

three do. 4, 5, 11, 12, 16 and 20.

four do. 6, 7, 13, 14, 17 and 18.

five do. 15 and 19.

p^D = Diagonal pitch of rivets, in inches.

P_D = Do. do. do. between inner and middle rows of rivets for joint J. (Fig. 19).

p = Greatest pitch of rivets, in inches.

r = Percentage strength of plate, left between holes in greatest pitch compared with strength of the unperforated plate.

R = Percentage strength of rivet section compared with strength of the unperforated plate.

R^1 = Percentage strength of combined plate and rivet section (when every alternate rivet has been omitted in the outer, or in the outer and inner, rows) compared with strength of the unperforated plate.

S = Ultimate tensile strength of material of shell plates, in lbs. per square inch of section.

S = Ultimate shearing strength of material of rivets, in lbs. per square inch of section.

T = Thickness of shell plate, in inches.

T = Thickness of each butt strap, in inches.

% = r, R or R^1, whichever is found to be least, divided by 100.

When joints are used in boiler construction other than those shown in the attached sketches, or when any of the rivets are pitched less than two diameters apart, the particulars of such joints should be submitted for the consideration of the Senior Inspector.

I.—Ordinary Chain and Zigzag Riveted Joints.

$$\frac{100\,(p-d)}{p}=r.$$

$$\frac{100 \times S^1 \times d^2 \times \cdot7854 \times n \times C \times F}{S \times p \times T \times F^1}=R.$$

Given C, d F, F^1, n, T, to find p, so that r and R are equal

$$\frac{S^1 \times F \times d^2 \times \cdot7854 \times n \times C}{S \times F^1 \times T}+d=p.$$

Given C, F, F^1, n, T, r, to find p and d.

$$\frac{S \times F^1 \times r \times T}{S^1 \times F \times (100-r) \times \cdot7854 \times n \times C}=d.$$

$$\frac{S \times F^1 \times 100 \times r \times T}{S^1 \times F\,(100-r)^2 \times \cdot7854 \times n \times C}=p.$$

When d is found first, then :

$$\frac{100\,d}{100-r}=p.$$

Butt Straps.

Iron plates and iron butt straps or steel plates and steel butt straps :

Double butt straps :

$$\frac{5 \times T}{8}=T^1.$$

Single butt straps :

$$\frac{9 \times T}{8}=T^1.$$

For distance between Rows or Rivets, &c.

Iron and steel :

$$\frac{3 \times d}{2}=E.$$

Chain riveted joints, Figs. 2, 4, 6, 9, 11, not less than :

$$2 \times d=V.$$

See note 1 at the end.

Zigzag riveted joints, Figs. 3, 5, 7, 10, 12,

$$\frac{\sqrt{(11\,p+4d)\,(p+4d)}}{10}=V.$$

Diagonal pitch, Figs. 3, 5, 7, 10, 12 :

$$\frac{6p+4d}{10}=p^d.$$

II.—CHAIN AND ZIGZAG RIVETED JOINTS IN WHICH EVERY ALTERNATE RIVET HAS BEEN OMITTED IN THE OUTER ROW, OR IN THE OUTER AND THE INNER ROWS, SUCH AS ARE SHOWN IN THE FOLLOWING SKETCHES:—

$$\frac{100\ (p-d)}{p}=r.$$

$$\frac{F \times S^1 \times 100 \times d^2 \times \cdot 7854 \times n \times C}{F^1 \times S \times p \times T}=R.$$

$$\frac{100\ (p-2d)}{p}+\frac{R}{n}=R^1.$$

Butt Straps.

Where the number of rivets in the inner row is, double the number in the outer row.

Iron plates and iron butt straps or steel plates and steel butt straps.

Double butt straps;

$$\frac{5 \times T\ (p-d)}{8 \times (p-2d)}=T^1.$$

Single butt straps:

$$\frac{9 \times T\ (p-d)}{8 \times (p-2d)}=T^1.$$

When the number of rivets in the inner row is the same as in the outer row.

Double butt straps:

$$\frac{5 \times T}{8}=T^1.$$

Single butt straps:

$$\frac{9 \times T}{8}=T^1.$$

For distance between Rows of Rivets, &c.

Iron and steel:

$$\frac{3 \times d}{2}=E.$$

Chain riveted joints, Figs. 13, 14, 15, 16:

$$\frac{\sqrt{(11p+4d)\ (p+4d)}}{10}=V$$

or

$$2 \times d=V.$$

The *greater* of these two values of V, to be used. *See note 1 at the end.*

For joint K (Fig. 15):

$$2 \times d=V'.$$ *See note 1 at the end.*

Zigzag riveted joints, Figs. 17, 18, 19, 20:

$$\frac{\text{R. T. No. } 4882 \text{ A/01}}{\sqrt{(\frac{11}{20}\,p + d)\,(\frac{1}{20}\,p + d)}} = V.$$

Diagonal pitch, Figs, 17, 18, 19, 20:

$$\tfrac{3}{10}\,p + d = p^{D}.$$

For joint J (Fig. 19):

$$\frac{\sqrt{(11p + 8d)\,(p + 8d)}}{20} = V^{1}$$

Diagonal pitch (Fig. 19):

$$\frac{3p + 4d}{10} = P_D.$$

III.—Maximum Pitches for Riveted Joints.

T = Thickness of plate, in inches.

p = Maximum pitch of rivets, in inches, provided it does not exceed 10 inches.

C = Constant, applicable from the following table:—

Number of Rivets in one Pitch.	Constant for Lap Joints.	Constants for Double Butt Strap Joints.
1	1·31	1·75
2	2·62	3·50
3	3·47	4·63
4	4·14	5·52
5	...	6·00

$$(C \times T) + 1\tfrac{5}{8} = p.$$

When the work is first class, such pitches may be adopted so far as safety is concerned, yet in some cases it may be well not to adopt the greatest pitch found by the formulæ. The maximum pitch should *not*, however, exceed 10 inches with the thickest plates for boiler shells. If in any case the pitch is found to exceed that arrived at by the foregoing formulæ, for the particular description of joint and thickness of plate, such pitches should *not* be passed, but in all cases reported to the Senior Inspector.

Note 1.—The minimum value of V or V^1 for chain riveted joints is given as $2d$, but $\frac{4d + 1}{2}$ is more desirable.

N. B.—When the rivet holes are *punched*, the factor of safety will be affected as instructed in table to Rule 28 and the above formulæ for *drilled holes* then applied.

IV.—To determine the Working Pressure.

$$\frac{S \times \% \times 2T}{F \times D} = B.$$

DETERMINING THE AUTHORITIES DEEMED COMPETENT TO GRANT CERTIFICATES OF COMPETENCY.

Notn. No. 4761, General, dated 9th September 1903, para. 72, B. G. G., 1903, Pt. I, p. 1111.

* * *

72. (1) The authorities below mentioned shall be deemed to be competent authorities within the meaning of section 22 by which Engineers in possession of a certificate of competency granted by such authorities are entitled to receive certificates of competency under this Act without undergoing further examination:

The Board of Trade.
The Steam Navigation Board, Victoria.
The Minister of Marine and Fisheries, Canada.
The Marine Department, New Zealand.
The Marine Board, New South Wales.
The Head of the Government, Malta.
The Marine Board, South Australia.
The Board of Examiners under the authority of the Governor of Tasmania
The Calcutta Marine Board (*i.e.*, the Lieutenant Governor, Bengal).
The Burma Boiler Act Board.
The Straits Settlements Board.
The Marine Board, Queensland.
The Governor, Hongkong.
The Bombay Marine Board (*i.e.*, the Governor of Bombay).
The Marine Board, Karáchi.
The Commandant, School of Military Engineering, Chatham.
The Commanding Royal Engineer, Southern District, Portsmouth.
The Commanding Royal Engineer, Western District, Plymouth.
[a] The Board of Examining Engineers of the United Provinces.
[b] The Marine Board, Aden.
[c] The Burma Marine Board.
[d] The Commandant, Ordnance College, Woolwich.

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[a] This addition was made by G. N. No. 1725, General, dated 5th April 1904, *B. G. G.*, 1904, Pt. I, p. 416.

[b] This addition was made by G. N. No. 3478, General, dated 6th July 1904, *B. G. G.*, 1904, Pt. I, p. 892.

[c] This addition was made by G. N. No. 3762, General, dated 20th July 1904, *B. G. G.*, 1904, Pt. I, p. 977.

[d] This addition was made by G. N. No. 3522, General, dated 27th June 1905, *B. G. G.*, 1905, Pt. I, p. 784.

(2) In the case of non-commissioned officers in the Royal Engineers [a] and Smiths in the Royal Garrison Artillery [a] for whom a certificate is necessary in order that they may be placed in charge of boilers used for military purposes, the following procedure will be observed:

[b] Application shall be made [b] to the Collector of Bombay or Karachi [a] or to the First Assistant Resident at Aden, as the case may be [a] for a certificate for the noncommissioned officer [a] or Smith [a] supported by the necessary British certificate of competency of the "Superior" or "Very superior" class. The application shall be at once circulated to at least four of the members of the Board of Examiners and a third class certificate in Form D, Appendix B, shall be signed by them and forwarded post free to the officer making the application.

No process of identification is necessary for the granting of this certificate which will entitle the non-commissioned officers [a] and smiths [a] receiving it to be placed in charge of military boilers only.

(3) All other applications under section 22 shall be made under rule 76 and the certificates granted shall be in Form C, Appendix B. The fact of such fresh certificate having been granted, shall be endorsed on the original qualifying certificate.

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RULES AND ORDERS UNDER BOMBAY ACT I OF 1892.

(DISTRICT VACCINATION).

APPLYING THE ACT EXCEPTING SECTION 33 TO THE MUNICIPAL DISTRICT OF LA'RKHA'NA IN THE SHIKA'RPUR DISTRICT.

Notn. No. 6847, General, dated 14th December 1898, B. G. G., 1898, Pt. I, p. 1132.

In exercise of the powers conferred by clause (*b*) of sub-section (2) of Section 2 of the Bombay District Vaccination Act, 1892, the Governor in Council is pleased to direct that the whole of the Bombay District Vaccination Act, with the exception of Section 33, shall come into force in the Municipal district of Lárkhána in the Shikárpur District of Sind within its extent on the 1st of January 1899.

BRINGING THE ACT INTO FORCE IN THE MUNICIPAL DISTRICT OF BÁNDRA AND KURLA IN THE THÁNÁ DISTRICT.

Notn. No. 3564, General, dated 7th July 1900, B. G. G., 1900, Pt. I, p. 1372.

In exercise of the powers conferred by clause (*b*) of sub-section (2) of Section 2 of the Bombay District Vaccination Act, 1892, the Governor in

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[a.—a] These words were inserted by G. N. No. 3522, General, dated 27th June 1905, *B. G. G.*, 1905, Pt. I, p. 784.

[b—b] These words were substituted for the words "The officer in charge of the submarine defences at Bombay or Karáchi shall make an application" by G. N. No. 3522, General, dated 27th June 1905, *B. G. G.*, 1905, Pt. I, p. 784.